

What is claimed is:

1. A strength-enhancing apparatus for a metal part for enhancing strength of a surface of said metal part, comprising:

a metal part-holding mechanism for positioning and holding said metal part in a processing chamber;

a projecting mechanism for projecting a spouting stream of glass beads and liquid from a nozzle toward said surface of said metal part; and

a recovery mechanism for recovering powder flow dust generated from said glass beads crushed on said surface of said metal part, wherein:

said recovery mechanism includes a liquid-spouting means arranged at least at a wall and a ceiling of said processing chamber, for effecting showering in the whole interior of said processing chamber so that said liquid is spouted toward said powder flow dust floating in said processing chamber.

2. The strength-enhancing apparatus for said metal part according to claim 1, wherein said liquid-spouting means includes a plurality of water-spouting nozzles.

3. The strength-enhancing apparatus for said metal part according to claim 1, further comprising a classifying mechanism arranged on a downstream side of said recovery

mechanism, for classifying said powder flow dust and said liquid from drainage containing said powder flow dust and said liquid in a mixed manner.

5 4. The strength-enhancing apparatus for said metal part according to claim 1, further comprising:

 a door structure for opening/closing an opening of said processing chamber for attaching/detaching said metal part, wherein said door structure includes:

 an inner slide door arranged on a side of said opening;

 an outer slide door arranged at the outside of said inner slide door;

 a driving means for automatically moving said inner slide door back and forth in an opening or closing direction; and

 a pressing means for allowing an inner side surface of said inner slide door to make tight contact with an outer wall of a casing for forming said processing chamber when said inner slide door is closed by the aid of said driving means.

20 5. The strength-enhancing apparatus for said metal part according to claim 4, further comprising:

25 an engaging means for engaging said outer slide door with said inner slide door to move said outer slide door in said opening direction when said inner slide door is moved in said opening direction by the aid of said driving means;

and

a release means for releasing engagement between said outer slide door and said inner slide door effected by said engaging means in a state in which said outer slide door is arranged at an open position.

6. The strength-enhancing apparatus for said metal part according to claim 4, wherein said pressing means includes:

a cam follower provided on said inner slide door; and
a cam member provided on said casing, for making contact with said cam follower to retract said inner slide door toward said opening.

7. The strength-enhancing apparatus for said metal part according to claim 1, wherein said metal part-holding mechanism includes:

a spindle unit provided with a driving rotary section for making rotation while supporting a first end of said metal part;

a support means provided with a driven rotary section which is movable while supporting a second end of said metal part; and

a cylinder for pressing said driven rotary section toward said second end of said metal part to interpose said metal part by using said driven rotary section and said driving rotary section.

8. The strength-enhancing apparatus for said metal part according to claim 7, further comprising:

a position-adjusting means capable of adjusting positions of said support means and said cylinder in an integrated manner in an axial direction of said metal part, wherein said position-adjusting means includes:

a guide member arranged in said processing chamber;

a sleeve member slidably inserted into the inside of said guide member, for installing said support means and said cylinder thereto; and

a movement means for moving said sleeve member back and forth in said axial direction.

9. A strength-enhancing apparatus for a metal part for enhancing strength of a surface of said metal part, comprising:

a metal part-holding mechanism for positioning and holding said metal part in a processing chamber;

a projecting mechanism for projecting a spouting stream of glass beads and liquid from a nozzle toward said surface of said metal part;

a recovery mechanism for recovering powder flow dust generated from said glass beads crushed on said surface of said metal part together with drainage; and

a classifying mechanism for classifying said recovered drainage into said liquid and said powder flow dust.

10. The strength-enhancing apparatus for said metal part according to claim 9, wherein said classifying mechanism includes:

first and second tanks for storing said classified liquid; and

a switching discharge means for selectively discharging said classified liquid to said first tank and said second tank.

11. The strength-enhancing apparatus for said metal part according to claim 10, wherein one of said first and second tanks is a tank for storing said liquid from which said powder flow dust is removed, and the other is a tank for storing impure liquid containing said powder flow dust in a mixed manner.

12. The strength-enhancing apparatus for said metal part according to claim 11, further comprising a supply mechanism for supplying said liquid in said liquid-storing tank to said recovery mechanism.

13. The strength-enhancing apparatus for said metal part according to claim 9, further comprising:

a door structure for opening/closing an opening of said processing chamber for attaching/detaching said metal part, wherein said door structure includes:

an inner slide door arranged on a side of said opening;

an outer slide door arranged at the outside of said inner slide door;

a driving means for automatically moving said inner slide door back and forth in an opening or closing direction; and

a pressing means for allowing an inner side surface of said inner slide door to make tight contact with an outer wall of a casing for forming said processing chamber when said inner slide door is closed by the aid of said driving means.

14. The strength-enhancing apparatus for said metal part according to claim 13, further comprising:

an engaging means for engaging said outer slide door with said inner slide door to move said outer slide door in said opening direction when said inner slide door is moved in said opening direction by the aid of said driving means; and

a release means for releasing engagement between said outer slide door and said inner slide door effected by said engaging means in a state in which said outer slide door is arranged at an open position.

15. The strength-enhancing apparatus for said metal part according to claim 13, wherein said pressing means includes:

a cam follower provided on said inner slide door; and

a cam member provided on said casing, for making contact with said cam follower to retract said inner slide door toward said opening.

5 16. The strength-enhancing apparatus for said metal part according to claim 9, wherein said metal part-holding mechanism includes:

 a spindle unit provided with a driving rotary section for making rotation while supporting a first end of said metal part;

 a support means provided with a driven rotary section which is movable while supporting a second end of said metal part; and

 a cylinder for pressing said driven rotary section toward said second end of said metal part to interpose said metal part by using said driven rotary section and said driving rotary section.

20 17. The strength-enhancing apparatus for said metal part according to claim 16, further comprising:

 a position-adjusting means capable of adjusting positions of said support means and said cylinder in an integrated manner in an axial direction of said metal part, wherein said position-adjusting means includes:

25 a guide member arranged in said processing chamber;
 a sleeve member slidably inserted into the inside of said guide member, for installing said support means and

said cylinder thereto; and

a movement means for moving said sleeve member back and forth in said axial direction.

5 18. A strength-enhancing apparatus for a metal part for enhancing strength of a surface of said metal part, comprising:

a metal part-holding mechanism for positioning and holding said metal part in a processing chamber;

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a projecting mechanism for projecting a spouting stream of glass beads and liquid from a nozzle toward said surface of said metal part; and

15 a recovery mechanism for recovering powder flow dust generated from said glass beads crushed on said surface of said metal part together with drainage, wherein said recovery mechanism includes:

an external air inflow port capable of introducing external air into said processing chamber;

20 a suction port which is open on a lower side in said processing chamber;

a chamber arranged in a discharge passage formed in communication with said suction port;

25 a suction means communicating with said chamber, for sucking said powder flow dust in said processing chamber from said suction port into said chamber; and

a liquid-spouting means for spouting said liquid toward said powder flow dust introduced into said chamber.

19. The strength-enhancing apparatus for said metal part according to claim 18, wherein a classifying mechanism for classifying said recovered drainage into said liquid and said powder flow dust is arranged on a downstream side of said recovery mechanism.

20. The strength-enhancing apparatus for said metal part according to claim 18, wherein said chamber includes:

a first chamber communicating with said discharge passage, for accommodating said liquid-spouting means; and
a second chamber communicating with a downstream side of said first chamber and communicating with said suction means.

21. The strength-enhancing apparatus for said metal part according to claim 20, wherein a classifying mechanism for classifying said recovered drainage into said liquid and said powder flow dust is arranged on a downstream side of said recovery mechanism.

22. A strength-enhancing apparatus for a metal part for enhancing strength of a surface of said metal part, comprising:

a metal part-holding mechanism for positioning and holding said metal part in a processing chamber;

a projecting mechanism for projecting a spouting stream of glass beads and liquid from a nozzle toward said surface

of said metal part;

a recovery mechanism for recovering powder flow dust generated from said glass beads crushed on said surface of said metal part together with drainage;

5 a classifying mechanism arranged on a downstream side of said recovery mechanism, for classifying said recovered drainage into said powder flow dust and said liquid; and

a powder flow dust-accommodating unit for storing said powder flow dust, wherein said recovery mechanism includes:

10 an external air inflow port capable of introducing external air into said processing chamber;

a suction port which is open in said processing chamber;

15 a chamber arranged in a discharge passage formed in communication with said suction port;

20 a communication passage for making communication between said powder flow dust-accommodating unit and said chamber;

a suction means communicating with said chamber, for sucking said powder flow dust floating in said processing chamber and said powder flow dust-accommodating unit into said chamber; and

25 a liquid-spouting means for spouting said liquid toward said powder flow dust introduced into said chamber.

23. The strength-enhancing apparatus for said metal part according to claim 22, wherein said chamber includes:

a first chamber communicating with said discharge passage and said communication passage, for accommodating said liquid-spouting means; and

a second chamber communicating with a downstream side of said first chamber and communicating with said suction means.

24. The strength-enhancing apparatus for said metal part according to claim 22, wherein said chamber includes:

a first chamber communicating with said discharge passage, for accommodating said liquid-spouting means; and

a second chamber communicating with a downstream side of said first chamber and communicating with said suction means; and

a third chamber communicating with upstream sides of said first and second chambers, for accommodating said liquid-spouting means, while communicating with said discharge passage and said communication passage.

25. A strength-enhancing apparatus for a metal part for enhancing strength of a surface of said metal part, comprising:

a door structure for opening/closing an opening of said processing chamber for attaching/detaching said metal part, wherein said door structure includes:

an inner slide door arranged on a side of said opening;

an outer slide door arranged at the outside of said

inner slide door;

a driving means for automatically moving said inner slide door back and forth in an opening or closing direction; and

5 a pressing means for allowing an inner side surface of said inner slide door to make tight contact with an outer wall of a casing for forming said processing chamber when said inner slide door is closed by the aid of said driving means.

26. The strength-enhancing apparatus for said metal part according to claim 25, further comprising:

an engaging means for engaging said outer slide door with said inner slide door to move said outer slide door in said opening direction when said inner slide door is moved in said opening direction by the aid of said driving means; and

a release means for releasing engagement between said outer slide door and said inner slide door effected by said engaging means in a state in which said outer slide door is arranged at an open position.

27. The strength-enhancing apparatus for said metal part according to claim 25, wherein said pressing means includes:

a cam follower provided on said inner slide door; and
a cam member provided on said casing, for making

contact with said cam follower to retract said inner slide door toward said opening.

5 28. A strength-enhancing apparatus for a metal part for enhancing strength of a surface of said metal part, comprising:

a metal part-holding mechanism for positioning and holding said metal part in a processing chamber, wherein said metal part-holding mechanism includes:

10 a spindle unit provided with a driving rotary section for making rotation while supporting a first end of said metal part;

15 a support means provided with a driven rotary section which is movable while supporting a second end of said metal part; and

20 a cylinder for pressing said driven rotary section toward said second end of said metal part to interpose said metal part by using said driven rotary section and said driving rotary section.

29. The strength-enhancing apparatus for said metal part according to claim 28, further comprising:

25 a position-adjusting means capable of adjusting positions of said support means and said cylinder in an integrated manner in an axial direction of said metal part, wherein said position-adjusting means includes:

a guide member arranged in said processing chamber;

a sleeve member slidably inserted into the inside of said guide member, for installing said support means and said cylinder thereto; and

a movement means for moving said sleeve member back and forth in said axial direction..

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